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- USSR -

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THE EFFECT OF THE SCHOOL SCHEDULE UPON THE FATIGUE OF FIRST-GRADE PUPILS

[This is a translation of an article written by L. I. Figlin in Trudy Leningradskogo Sanitarno-Gigiyenicheskogo Meditsinskogo Instituta (Works of Leningrad Sanitary Hygienic Medical Institute), Vol 31, Leningrad, 1956, pages 41-60.]

Study at school, as a physiological process, represents a gradual formation of a complex chain of conditioned associations in the cerebral cortex, with the participation of the primary and secondary signal systems.

To the cortical analyzers of a child, who first familiarizes himself with the alphabet, all letter-symbols appear as stimuli of a uniform character (generalization). Only later, by means of the development in the cortical cells of positive, differentiating and integrating conditioned associations, does there appear the ability to recognize letters and the creation of habits of word formation, reading, and writing.

With a proper regime of educational work, the relatively optimal state of cortical dynamics can be retained for a long time.

Under unfavorable hygienic conditions of educational studies, and depending on the functional state of the nervous system, there may appear changes in the correlation of cortical processes up to the emergence of postliminal inhibition.

The higher nervous activity of children has, on the strength of age-related physiological peculiarities, functional possibilities which are characteristic of each age group. Therefore, one must assume that the existing uniform educational regimen in the junior and senior grades, particularly the class length of 45 minutes that is uniform in all grades does not correspond to that age-group's physiological capacities and is, therefore, incorrect.

This problem, the fatigue problem of pupils, has attracted the attention of physicians, physiologists, psychologists and teachers for a long time. At the base of its study are principally two methods. The majority of old investigations, starting with the first work in this field

of the Russian psychiatrist, I. A. Sikorskiy (1879), works of F. N. Telyatnik (1897), A. P. Nechayev (1901), L. Burgerstein's (1891), Bourdon's (1895), A. Binet (1905), et al., is based on observation of changes in children, under the effect of educational work, of certain psychic processes -- attention, memory, and associative ability -- which reflect the status of the central nervous system.

Other investigations are built on observation of the functional state of various sections of the nervous system. They are the esthesiometric method of H. Griesbach (1895), the ergographic method of A. Mosso (1892), the W. Weichardt method of physical exercises (1907), etc.

These methods have been retained up to the present time. The majority of modern investigators of fatigue of pupils utilize either one of these methods, or both. For instance, the works of Kh. S. Rivlina (1951) and N. M. Serebro (1951) are based on the determination of changes in certain psychic processes combined with pedagogic observations. In the studies of M. V. Antropova (1953, 1955), L. V. Mikhaylova (1954, 1955), G. P. Sal'nikova (1952, 1953, 1955), E. G. Kaplun (1953), M. I. Varaskin (1955), etc., parallel with observation of the state of various psychic processes, an observation is employed of changes in a number of indices of the functional state of the nervous system -- muscle chronaxy, electrical sensitivity of the eye, duration of clear vision, of the Ashner ophthalmocardiac reflex, etc., which indirectly reflect the status of higher nervous activity in the investigated children.

There is a small individual group of investigations which consists of direct observation of the reaction of the cerebral cortex and of evaluating the changes in conditioned reflex associations, as well as correlations between the primary and secondary signal systems. L. S. Bogachenko (1951, 1953, 1954) conducted a study of school fatigue by means of motor-speech methods of A. G. Ivanov-Smolenskiy.

In considering the school-day schedule -- a very important hygienic problem -- the Chair of School Hygiene of the Leningrad Sanitary Hygienic Medical Institute [LSGMI] decided to subject it to thorough study, and it thought that direct observation of the reaction of the central nervous system of children must constitute the basis of methods of such study. The present work is devoted to the study of this problem in relation to first grade pupils.

The following methods are used in this work.

1) Development of conditioned motor reflexes to speech strengthening according to the A. G. Ivanov-Smolenskiy method (1933);

2) Evaluation of changes of the latent period of reactions to stimuli of various intensity (in the modification suggested by A. V. Lifshits)(1);

3) Study of the interaction of the primary and secondary signal systems according to the method of the Ivanov-Smolenskiy laboratory;

4) Observations of the stimulus transfer from the primary to the secondary signal system (the simultaneity of its origin in both signal systems);

5) Development and study of temporary conditioned associations in the group;

6) Evaluation of changes of certain psychic processes.

The work was carried out in ten first grade classes of Leningrad schools -- five experimental classes and five controls in the following schools: No 14 -- Director L. K. Zabolotskaya, teachers L. Ya. Yegorova and V. M. Aleksyeva; No 138 -- Director L. G. Rukavishnikova, teacher A. S. Shcherbakova; No 142 -- Director L. F. Kurakina, teacher Ye. P. Il'yushenko; No 251 -- Director A. I. Nikitina, teacher A. I. Zakharova. In each class five, eight, or 10 pupils were selected for individual studies. A total of 41 children were under observation in the experimental classes, and 25 -- in the control classes. Each child was subjected to several tests, from four to six and up to seven or eight tests, sometimes even more. Each experiment consisted of two tests before the start of the school day and after its termination.

The experimental and control classrooms were adjacent the condition of the air, heat regimen, regimen of ventilation, and number of pupils in them were basically identical. In the experimental classes, after a brief period of observations under conditions of the usual school schedule which lasted about two weeks (not counting the time of preliminary training of the children selected for observation), an altered regime was introduced: the lessons were shortened to 35 minutes and the recesses were correspondingly extended 10 minutes, which were conducted in the form of organized games; after a certain period of observations under these conditions, another hygienic measure was introduced -- the recess period was spent in the open air, in the courtyard.

The majority of experiments was conducted according

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(1) Gigiyena i Sanitariya (Hygiene and Sanitation), 1954, No 3, page 40, in the article of A. I. Shafir, M, S. Darmancheva and Ye. I. Solomonova.

to the method of evaluation of changes of the latent period of reactions to stimuli of various intensity. At the basis of this method lies the "rule of force," according to which one has to expect a stronger reaction and shorter latent period from the action of a stronger stimulus.

The observations were carried out by means of a device suggested by A. V. Lifshits and constructed by engineer N. N. Shved, of a type of chronoscope built in the experimental shops of LSGMI (Figure 1). The device is mounted in the form of a portable valise and consists of: a) a control board and a device to calculate the figures of the latent period, b) a signal part with a device to effect motor reactions, and c) a reflexometer. The device can emit four signals varying in their character and force: strong and weak sound, strong and weak light, and a fifth signal -- red light.

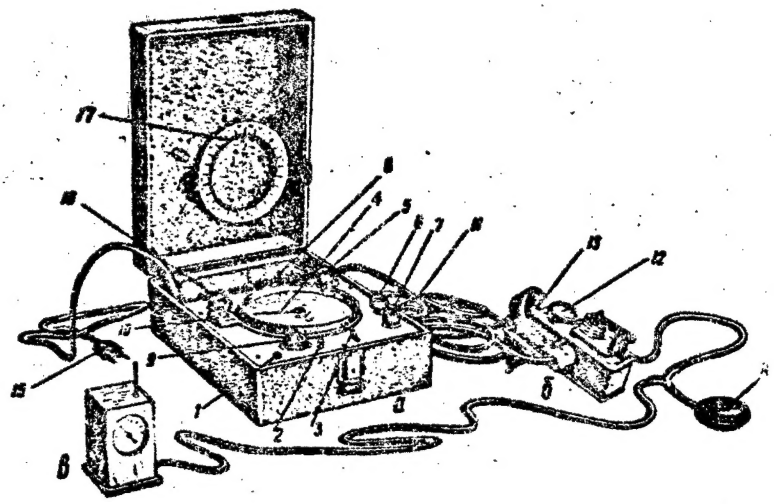

Fig. 1. External appearance of the device used for the study of fatigue of pupils.
a) control board and the recording part; b) signal part; c) reflexometer; 1, 3 -- switching-on the current; 2, 7 -- signal control; 5, 6 -- resistance rheostats; 4 -- pointer and dial; 8 -- place for the signal part; 9, 10 -- accessory parts for the operation of signals; 11 -- hose and wiring; 12, 13 -- light and sound signals; 14 -- rubber balloon and pneumatic transfer; 15 -- electric; 16 -- voltage commutator; supplementary scale.

During the experiment the observed child receives a definite number of stimuli, 16 or 20, and the number, once-accepted, is adhered to during the entire period of observations.

The stimuli consist of the above-mentioned four signals which are repeated four or five times during the experiment at various sequences, which also are adhered to during the entire period of observations. The order of the signals is arranged in such a way as to adhere to a definite combination of strong and weak stimuli. For example:

1. Strong light
2. Strong sound
3. Weak sound
4. Weak light
5. Strong sound
6. Strong light
7. Weak light
8. Weak sound
9. Strong sound
10. Weak sound
11. Strong light
12. Weak light
13. Weak sound
14. Strong sound
15. Strong light
16. Weak light
17. Strong sound
18. Strong light
19. Weak sound
20. Weak light

Prior to the start of each experiment the child receives a certain number of signals, but these reactions are not taken into account; their purpose is to eliminate the possible effect of "working in," of recalling the usual rate of the reaction, etc.

At the end of the experiment, a pair-by-pair comparison of the length of the latent period of reactions is made (to a strong sound and strong light, weak sound and weak light, strong and weak sounds, strong and weak lights). A shorter reaction period for a strong stimulus than for a weak one in the compared pair offers a basis for considering the analyzed reaction of the central nervous system to be a normal one. Upon a change in the cortical dynamics, especially with the emergence of protective inhibition, there is a change in the length of the latent period, the number of normal reactions may decrease at the expense of an increase of the number of reactions of the equalizing and paradoxical inhibitive phases, which are characterized either by an equal or greater length of the latent period of reaction to a strong stimulus, as compared with the magnitude of the reaction to a weak stimulus.

As a result of the fact that each signal is repeated four or five times during the experiment (depending on the accepted standard), there are about 20 to 30 such comparable pairs of the latent period created after the experiment.

The results of the comparison may be summarized and written down; in this connection, the notes will resemble a formula; for example, N_{18}, U_6 P_4 / N_{18} E_6 P_4 / means that there were in the experiment 18 normal, six equalizing, and four paradoxical reactions.

For instance, after an experiment on 1 November 1955 on pupil M. O. the following results were obtained:

Befor classes at 8 hours 50 minutes: N_{27} E_2 P_1

After classes at 13 hours: N_{14} E_4 P_{12}

The data of the cited experiment indicate worsening of the state of the central nervous system in M. O. at the end of the school day: a smaller number of normal reactions and more phase-reactions -- especially paradoxical ones.

The data of these studies showed that, after classes during the regular school schedule period, the number of normal reactions decreases in the majority of tested pupils while the number of phase-reactions increases; but, under conditions of a changed school-day schedule, there are very few such cases, and in the preponderant majority of cases the difference between the results of tests before and after classes is very small -- often completely absent. As an

example, we show diagram matically the results of two experiments under conditions of a regular and a changed school-day schedule (Fig 2).

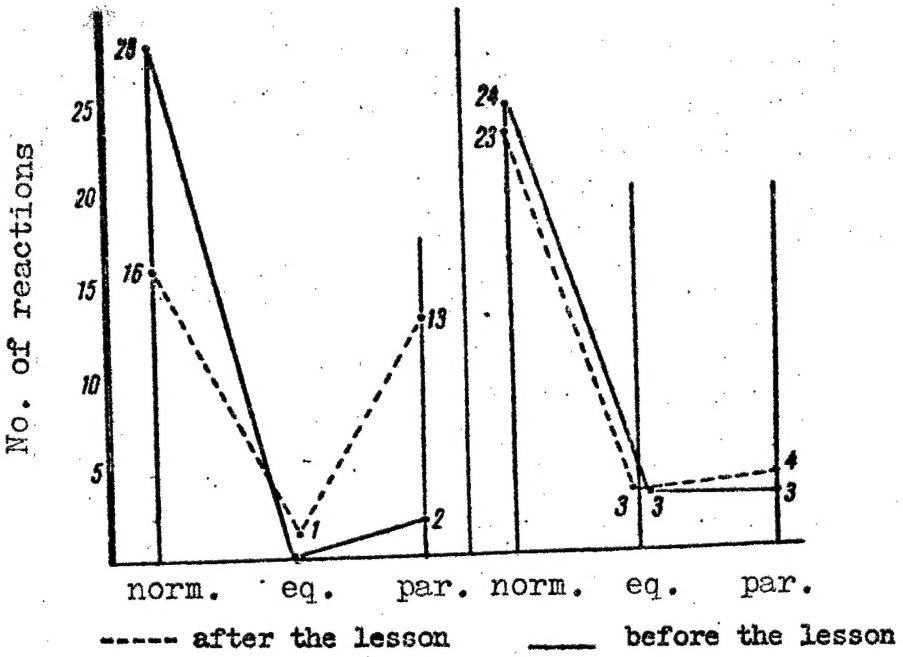

Fig. 2. Change in the number of normal, equalizing, and paradoxical reactions in the pupil Tolya U. during a school day.

Left: Under conditions of a regular school-day schedule on 22 February 1955.

Right: Under conditions of a changed school schedule on 14 March 1955.

Conventional symbols: norm.-- normal reaction
eq. -- equalizing reaction
par. -- paradoxical reaction

* *
*

The development of conditioned reflexes on vocal strengthening according to the Ivanov-Smolenskiy method was conducted by means of the same device, for which purpose certain additional adjustments were introduced.

As the studies have demonstrated, phenomena of considerable changes of cortical dynamics up to postliminal inhibition are observed mainly after classes in children under conditions of a regular school-day schedule; however, under experimental school regiemen the class work

at school is much less reflected in the course of cortical process of the pupils.

As an example, we cite excerpts from the records of various experiments.

In Kolya B., as seen from the cited records of the experiment (Table 1), after classes during the period of a regular school-day schedule (Record of 20 January), there occurred phenomena of weakening of the process of differentiation (active internal) inhibition which manifested itself in the disinhibition of differentiations, as well as weakening of the irritation process which expressed itself in the disappearance of the positive conditional reaction, in the lengthening of the latent period of reaction, and in the reduction of its size (before classes the mean range of the latent period(1) was 1.44, per conventional divisions of the chronoscope scale; the mean size of the reaction was 60 divisions on the reflexometer; after classes they were respectively: 2.27 and 46); a reduction of the mobility of cortical processes is observed, which manifested itself in a markedly expressed and fairly stable subsequent inhibition. These facts indicate the emergence of protective inhibition in Kolya B. toward the end of the school day.

Under conditions of a changed schedule (Record of 8 April) the above-mentioned phenomena of impairment of cortical dynamics are absent in the majority of cases; only a slight reduction of the average figure of the latent period is noted (1.41 before classes, 1.38 after classes, according to convential divisions of the chronoscopic dial), with a scarcely changed reaction figure (before classes 64.8, after classes 65.1); the character of the consecutive inhibition before classes is nearly the same as after classes (Table 1).

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(1) The mean arithmetic figure of the sum of all figures of the latent period reactions, which take place during a given test in response to a given (positive) stimulus.

Table 1

Kolya B. 20 January 1955.

Before classes

Number of the experiment positive	Number of the experiment differentiated	pause in (seconds)	Stimulus	order	latent period (in conventional units of chronoscopic scale)	reinforcement	degree of conditioned reaction
1			light-2*		1.76	+	58
2		11	light-2		0.9	+	64
	3	12	light-1*		-	+	--
8		19	light-2		2.12	+	50
12		16	light-2		1.4	+	60
	4	17	light-1		-	+	--
13		18	light-2		1.42	+	56
17		20	light-2		0.9	+	64
	6	12	light-1		-	+	--
23		18	light-2		1.2	+	62
	7	13	light-1		-	+	--
24		20	light-2		1.26	+	62
25		10	light-2		1.0	+	64

*light-1 = strong light, light-2 = weak light.

Table 1 Continued

Kolya B. 20 January 1955.

After classes

Number of the experiment		pause in (seconds)	stimulus	order	latent period (in conventional units of chronoscopic scale)	rein-forcement	degree of conditioned reaction
positive	differentiated						
1			light-2				38
2		10	light-2	+	2.26	+	50
3		20	light-2		1.92	+	48
	2	21	light-1		-	+	--
9		14	light-2		3.80	+	40
17		20	light-2		1.82	+	50
	4	19	light-1		1.72	-	36
18		15	light-2	+	3.17	+	39
19		23	light-2		2.26	+	40
	5	14	light-1		-	+	--
21		19	light-2		3.0	+	47
25		10	light-2		1.92	±	50
	7		light-1		1.9	-	40
26		19	light-2	+	2.96	+	32

*light-1 = strong light, light-2 = weak light.

8 June 1955

Before classes

Number of the experiment: positive	Number of the experiment: differentiated	pause in (seconds)	stimulus	order	latent period (in conventional units of chronoscopic scale)	reinforcement	degree of conditioned reaction
1			light-2		1.26	+	64
2		14	light-2		1.12	+	68
4		17	light-2		0.92	+	70
7		10	light-2		1.06	+	68
	1	12	light-1		-	+	--
8		16	light-2		1.64	+	58
12		19	light-2		0.94	+	67
	3	19	light-1		-	+	--
13		12	light-2		1.92	+	58
21		26	light-2		1.12	+	67
	5	12	light-1		-	+	--
22		14	light-2		2.02	+	54
26		19	light-2		1.04	+	70
	6	12	light-1		-	+	--
27		14	light-2		1.76	+	60

*light-1 = strong light, light-2 = weak light.

Continued

8 June 1955

After Classes

Number of the experiment		pause in (seconds)	stimulus	order	latent period (in conventional units of chronoscopic scale)	reinforcement	degree of conditioned reaction
positive	differentiated						
1			light-2		1.34	+	65
2		12	light-2		1.12	+	68
4		15	light-2		1.0	+	72
7		10	light-2		1.0	+	66
	1	11	light-1		-	+	--
8		15	light-2		1.86	+	50
12		19	light-2		1.1	+	68
	2	21	light-1		-	+	--
	3	14	light-1		-	+	--
13			light-2		1.82	+	51
17		15	light-2		1.06	+	68
	4	19	light-1		-	+	--
18		17	light-2		1.6	+	62
21		14	light-2		0.9	+	68

*light-1 = strong light, light-2 = weak light.

It is important to note one phenomenon observed in Kolya B.: during the experiments of the period of the regular school-schedule he arbitrarily rearranged the conditioned reactions in two tests conducted after classes; he reacted to positive stimuli as to differentiated ones, and vice versa. In both these cases we refrained from reinforcements and any instructions whatever, and the test was completed after six to eight combinations. On the following day the positive and differentiated reactions were correct. After switching to a changed school schedule, he showed no arbitrary rearrangements. A total of five tests with a regular schedule and five tests with a changed schedule were carried out on this boy (not counting the tests on the development and fixation of the conditioned reactions).

Second example. The positive conditioned reflex developed very slowly in the pupil Alla S.; the first conditioned reaction was formed on the 36th combination, and even here -- after the use of short pauses and the approximation and up to the concurrence of both stimuli the conditional signal and the vocal reinforcement -- the fixation was formed on the 48th combination. On the following day the reaction was securely effected starting with the second combination. But when, after ten combinations, a new stimulus was given for the first time (with a corresponding order) to form a differentiation (which, by the way, was fixed starting with the third combination and never fell out subsequently), the positive reaction fell out and was never reestablished up to the end of the experiment. The reaction was reestablished during the following experiment with the 34th combination and was fixed starting with the 40th combination.

In subsequent tests there were no such clear facts observed of the manifestation of predominance of the inhibitive process, but, upon the emergence of unfavorable conditions for the higher nervous activity during a school day, precisely this positive reaction suffered, the coordination of cortical processes inherent in a given child was impaired, the irritation process was weakened, and the inhibitive process predominated. In one of the experiments, for example, under conditions of the school schedule, the falling-out of the positive reaction took place before classes in 13 percent of the combinations, and after classes -- in 31 percent of the combinations; but in the experiment carried out under conditions of a changed school regimen no such effect of the school day was observed on the course of cortical processes inherent in a given child; the falling-out

of the positive reaction was about the same before and after classes -- 8.5 and 7.5 percent, respectively.

The reduction of excitability toward the end of the school day under conditions of the regular school schedule manifested itself also in the increase of the mean figure of the latent period reaction: during the regular school schedule it constituted in the cited experiment before classes 1.77 conventional units, according to the chronoscopic scale, and after classes it was 4.33. In the experiment with a changed schedule the increase in the latent period was very slight and constituted, respectively, 1.96 units before classes and 2.24 units after classes on the chronoscopic scale.

Also significant are the results of experiments on the pupil Tanya D. In her a positive conditioned reflex was developed on weak light and a differentiation on a strong light. Subsequently, an additional differentiation was developed on a complex stimulus -- weak light and weak sound, and after a certain time -- a positive reaction to a weak sound. A total of 16 combinations were required to develop the latter reaction (to a weak sound) in this girl, whereas the other conditioned associations, the positive and differentiated ones, were formed after two to three combinations (Table 2).

Table 2

Tanya D., 4 Nov 1955

Before classes

No of the experiment: positive reaction	differentiation reaction		stimulus	order	latent period (under conditional units of the chronoscope scale)	reinforcement
			light-2*			+
10			light-1*		1.08	+
	2		light-2+		-	
		1	sound-2		-	+
			.....			
			sound-2		1.72	+
4			sound-2		1.02	+
5			light-2+			
		2	sound-2		-	+
	3		sound-1		-	+
			sound-2		1.36	+
8			sound-2		1.45	+
9			.....			
			sound-2		1.2	+
10			sound-2		1.38	+
12			.....			
			sound-2		0.99	+
13			sound-2		1.05	+
14			light-2		1.02	+
15			sound-2			
16						

*Sound-2 = weak sound; light-2 = weak light; light-1 = strong light

Table 2 Continued

After classes					
No of the experiment positive reaction	differentiation reaction	stimulus	order	latent period (under conditional units of the chronoscope scale)	reinforcement
8		light-2		1.14	+
		light-2+			
	1	sound-2		-	+
	1	sound-2	+		
	2	"	+		
	3	"		2.33	+
	4	"		2.12	+
12		light-2		1.13	+
	5	sound-2		2.42	+
	6	"		1.92	+
		.....			
	7	sound-2	+		
		.....			
	8	sound-2		2.72	+
	9	"		1.84	+
		.....			
	10	sound-2		1.2	+
		light-2+			
	3	sound-2		1.09	-
18		light-2		1.12	+
		.....			
		light-2+			
	4	sound-2		-	+
		.....			
		light-2=			
	5	sound-2		-	+
	14	sound-2	+		

*Sound-2 = weak sound; light-2 = weak light; light-1 = strong light

Thus the complex signal served as a negative stimulus, and each of its two components separately -- as positive stimuli; in this connection, to one of these (weak light) a positive reaction was formed prior to the formation of a negative reflex to the complex, and to the second (weak sound) -- after the development of a negative reflex to the complex. Precisely this second component of the complex signal -- the weak sound -- proved to be, in this case, a very sensitive indication of the effect of the school day on the state of higher nervous activity during a different schedule of the school day.

Under conditions of a regular school schedule, the conditioned association in regard to this stimulus would quite frequently fall out in experiments after classes, and its reestablishment usually proved unstable: before the end of the experiment the reaction often fell out again two or three times, the latent period increased, and the degree of the reaction was reduced; not infrequently there was also observed the release of the above-mentioned differentiation in a complex stimulus. Thus, the data of the record indicate the development of phenomena of postliminal inhibition during the school day.

Under conditions of a changed school schedule, the conditioned association in regard to a weak light would also disappear at times at the end of a school day; in these cases, however, its reestablishment would rapidly take place -- generally after the first reinforcement, and would be preserved up to the end of the experiment; other disturbances of conditioned associations also took place considerably later than during the period of the regular school day schedule.

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In order to elicit the effect of the school-day schedule on the interrelations of the primary and secondary signal systems we employed two methods:

first -- an oral report by the child on the test that was carried out, as described by L. S. Bogachenko and other authors (1953);

second -- the method, which we had suggested, of the oral evaluation of each of the two signals issued simultaneously (of each of the two components of the complex signal).

The oral report of the test under conditions of the regular school-day schedule gave us results analogous to

those obtained by L. S. Bogachenko. The analysis of oral reports by the pupils showed that toward the end of the school day there takes place, in a number of cases, a disturbance of correct correlation of the evaluation of both signal systems, either in the form of inadequate evaluation of their actions [by the pupils], or in the form of difficulty in presenting a complete report, whereas a full report could be obtained after a certain number of leading questions.

Under conditions of a changed school schedule, the number of such cases, i. e., incorrect and inadequate reports, was considerably lower, and almost totally absent when the recess was transferred outdoors.

According to the second method, the child must name and evaluate the components of the complex signal, which consists of sound and light stimuli of various intensity.

We shall cite as an example one such test carried out during the period of a regular school regimen (Table 3).

Table 3

Results of observation on the stimulus transfer from the primary to the secondary signal system

Pupil A. Ye.

Signals, questions	Answers (after question: "What was it now?"	Comments
Before classes:		
1) $Sound_1$*	Whistle	
2) $Sound_2$*	Whistle	
The same?	Low whistle	
3) S_2 + $Light_2$*	Whistle and small light	
4) S_1 + L_1*	Whistle and small light	
Same?	No, the sound is louder	
And the light?	Lighter, whiter	
5) L_1	Small light	
6) L_2	Small light, but yellowish	
7) S_2 + L_1	Whistle and small light	
Same?	The light is white	
8) S_1 + L_2	Whistle and light	
Same?	The whistle is more quiet	
And light?	(Silence)	Incorrect evaluation
Is the light the same?	The same	
9) S_1 + L_1	Whistle and s. light	

Table 3 Continued

Signals, questions	Answers (after question: "What was it now?"	Comments
Same?	No, the light is brighter and whiter	
10) $S_2 + L_2$	Small light and whistle	
Same?	The whistle sounds lower, but the light is the same	
11) S_2	Whistle	
12) S_1	Whistle is more quiet	
13) $S_1 + L_2$	Whistle	
What else?	(Silence)	
Was there anything else?	(Silence)	Falling out
14) $S_2 + L_2$	Whistle	
Nothing else?	(after a pause) Also a small light	
Are whistle and light the same?	(Silence)	
Try to recall, was it the same whistle?	No, not the same	
And what kind?	A little quieter	
And the light?	(Silence)	Difficulty
Try to recall, what kind of light?	Same kind of light	
After classes:		
1) S_1	Whistle	
2) S_2	Whistle	
Same?	Quieter	
3) $S_2 + L_2$	Whistle and small light	
4) $S_1 + L_1$	Whistle and small light	
The same?	Loud Whistle	
And the light?	(Silence)	
The same light?	The same	Incorrect evaluation
5) $S_2 + L_2$	Whistle	
Nothing else?	And small light	
The same?	No	
How different?	The whistle was more quiet	
And the light, the small light?	(Silence)	Difficulty
6) L_1	Small light	

Table 3 Continued

Signals, questions	Answers (after question: "What was it now?"	Comments
7) L_2	Yellow light	
8) $S_1 + L_2$	Whistle	
What else?	(Silence)	
Recall, what else was there?	(Silence)	Falling out
9) $S_1 + L_1$	Whistle	
What else?	Louder whistle	
And besides the whistle?	(Silence)	
Was there something else?	(Silence)	Falling out
10) $S_2 + L_1$	Small light and whistle	
Same?	(Silence)	Difficulty
11) S_2	Whistle	
12) L_2	Small light	
13) $S_1 + L_2$	Whistle	
What else?	(Silence)	
Was there anything else?	No, there was not	Falling out
14) $S_2 + L_2$	Whistle	
And what else?	Nothing	
Try to recall	(Silence)	Falling out

*Sound S_1 -- strong sound; S_2 -- weak sound; L_1 -- strong light; L_2 -- weak light

The results of the experiment are shown in Table 4, which also includes the results of one of the experiments with the same pupil that was conducted during the period of a changed school regimen.

From the cited table one can observe the advantage of a changed school schedule for the correct interaction of the signal systems.

Table 4

The number of errors in the evaluation of complex signals

Character of errors	Regular school regimen		Changed school regimen	
	before classes	after classes	before classes	after classes
Falling out of the signal	once	4 times	-	once
Incorrect evaluation of the signal	once	once	once	-
Difficulty in the evaluation of signal	once	twice	once	once
Total	3 times	7 times	twice	twice

* * *

We analyzed above the results of individual tests. We shall now pass on to a description of the collective investigations.

Two methods were employed in the collective investigations:

In the first place, the method of investigation of the state of certain psychic processes in the entire class, which has become known lately as the method of proportioned assignments.

In the second place, a method suggested by us for the development and investigation of conditioned associations in a group.

The results of investigations by the method of proportioned assignments, consisting of crossing out letters and solving arithmetical examples, are analogous to the results described by Kh. S. Pivlina in her study (1951); to this must be added that, after the children began to have their recess outdoors on a changed school schedule, the results of the day-test (after classes) were identical to the morning results in many pupils, and in some children even surpassed them as to the quantitative and, particularly, qualitative indices.

The last method employed in the present work consisted of the group-test of developing positive and differentiated conditioned associations in the entire class, as suggested by us.

Two electric flashlights of different intensity served as stimuli. The children were supposed to raise one hand

for a small light, and their other hand -- for a strong light. They were to lower their hands not after the light was switched off, but in response to a brief flash of the strong light. At the simultaneous lighting of both bulbs the hands were not to be raised.

A certain complication of the problem (the need for choosing the hand, etc.) was necessary to exclude imitation.

Three persons were required to conduct a record of these experiments -- one person for each row of benches. We cite below, as an example, two records of the morning and afternoon experiments during one day. It is worth while to provide here a preliminary clarification of how to fill out certain graphs of the records (Table 5).

Table 5

Record of the group experiment of the evaluation of the state of higher nervous activity

Date, time of experiment	Object of observation and number of children	No of test	Designation of first signal	Order	Reinforcement	Errors of 1st signal (raising of hand) Number of errors of lifting of hand (the wrong hand)	No of those who hesitated	Notations 25 percent of those observed	50 percent of those observed	75 percent of those observed	all (almost all)
1	2	3	4	5	6	7	8	9	10	11	12
10 Dec, Start of first class	third row, 14 pupils	1	weak		+	-	-	-	-	-	-
		2	weak		+	-	-	-	-	-	-
		3	weak		+	-	-	-	-	-	-
		4	strong		+	-	-	-	-	-	-
		5	strong		+	-	$1(4_2)$	-	-	-	-
		6	3		+	$1(1_1)$	-	-	-	-	-
		7	3		+	-	$1(4_2)$	-	-	-	-
		8	strong		+	-	-	+	-	-	-
		9	strong		+	$1(4_2)$	-	+	-	-	-
		10	weak		+	-	$1(1_1)$	-	-	-	-
		11	weak		+	-	-	-	-	-	-
		12	3		+	-	1	-	-	-	-
		13	strong		+	-	-	-	-	-	-
			Total			2	4	two times			
10 Dec, after fourth class	third row, 14 pupils	1	weak		+	-	1	-	-	-	-
		2	weak		+	-	-	-	-	-	-
		3	weak		+	1	-	-	-	-	-
		4	strong		+	2	-	-	-	-	-
		5	strong		+	2	-	3	-	-	-
		6	3		-	-	-	-	-	-	-
		7	3		+	-	$1(1_1)$	-	-	-	-
		8	strong		+	2	-	-	-	-	-

Table 5 Continued

Date, time of experiment	Object of observation and number of children	No of test	Designation of first signal	Order	Reinforcement	Errors of 1st signal (raising of hand)					
						Number of errors of lifting of hand (the wrong hand)	No of those who hesitated	Notations			
								25 percent of those observed	50 percent of those observed	75 percent of those observed	all (almost all)
1	1	2	3	4	5	6	7	8	9	10	11	12
		9	strong		+	2	-	-	-	-	-
		10	weak		+	2	-	-	-	-	-
		11	weak		+	-	-	-	-	-	-
		12	3		+	-	-	-	-	-	-
		13	strong		+	1	-	-	-	-	-
			Total			12	2	once	once	once	-

Designations: weak- weak light; strong - strong light; 1 - complete signal of strong and weak light

Table 5 Continued

No of test	Error in lowering hand: number of hands lowered too early	Error in lowering hand: number of those hesitating	Reinforcement	Second signal (to lower the hand)	Reinforcement	Error of second signal	Class 1b instructions: particular	Class 1b instructions: general
3	13	14	15	16	17	18	19	20
1	1	-	-	+	+	-	-	+
2	-	1	-	+	+	-	-	-
3	-	-	-	+	+	-	-	-
4	-	-	-	+	+	1	-	-
5	-	-	-	+	+	-	-	-
6	-	-	-	0	0	-	-	-
7	-	-	-	0	0	-	-	-
8	-	-	-	+	+	-	-	-
9	-	-	-	+	+	-	-	-
10	-	1(1_1)	-	+	+	-	-	-
11	-	-	-	+	+	-	-	-
12	-	-	-	0	0	-	-	-
13	-	-	-	+	+	-	-	-
Total	1	2	-	-	-	1	-	-
1	-	-	-	+	+	1	-	-
2	-	-	-	+	+	-	-	-
3	1	-	-	+	+	-	-	+
4	-	-	-	+	+	1	-	-
5	-	-	-	+	+	-	-	-
6	-	-	-	0	0	-	-	-
7	-	-	-	0	0	-	-	-
8	-	-	-	+	+	-	-	-
9	-	-	-	+	+	-	+(1)	+
10	-	-	-	+	+	-	-	-
11	-	-	-	+	+	-	-	-
12	-	-	-	0	0	-	-	-
13	-	-	-	+	+	1	-	-
Total	1	-	-	-	-	3	-	-

Thus, in the seventh graph the number of children who raised (steadily) the wrong hand, or did not raise it at all is recorded; an error continues to be considered an error if the child does not correct it voluntarily but in imitation of his comrades; it is often possible, in addition to counting the total number of errors, to note precisely who had committed the error; it is useful to enter these into the record by designating the order (place) of the bench in the row with one digit and the seat of the pupil on the bench with a smaller-sized digit below (figure 1 -- left hand seat, figure 2 - right hand seat); for example, 42 -- (pupil seated on the fourth bench, right).

In the eighth graph, in accordance with the same principle, is recorded the number of pupils who showed indecision in the selection of hand but immediately corrected their mistake.

In graphs 9 and 12 the number of children who lifted their hand after a certain delay is recorded; if there were 25 percent of such instances or less, a plus sign (+) is placed in graph 9 (if there are only a few, one can put down the quantity); if there are about 50 percent, a plus sign is placed in graph 10, etc.

In graph 13 is recorded the number of those who lowered their hands after the light had been switched off, without waiting for the special signal to lower hands.

In graph 14 is recorded the number of those who hesitated, or were doubtful in regard to lowering the hand ("began to lower the hand but lifted it again").

In graph 18 are recorded those who were late in lowering their hands or committed another error connected with lowering hands.

In graph 19 are recorded instances when (on account of errors or other reasons) it was necessary to give a particular instruction (some had forgotten which hand their left hand is"), and one therein designates, together with a plus, the category to which the error refers (I-- to differentiation in raising hands, II -- to errors in lowering the hand).

In graph 20 are recorded instructions of a general character ("someone stopped looking at me," "do not get distracted with extraneous matters").

The record of the afternoon experiment clearly indicates the reduction of higher nervous activity, as compared to the state observed during the morning experiment. Under conditions of a changed school-day schedule this difference is considerably smaller.

The records show manifest worsening of the state of

higher nervous activity after classes, as compared to the state before classes under a regular school schedule.

Under conditions of a changed school schedule this difference is considerably smaller, as can be seen from Table 6 where the results of two group-tests in one class are shown according to the indicated method under conditions of a regular and a changed school schedule.

Table 6

Evidence of change in cortical dynamics under conditional reactions of a group of pupils of grade 1B of school No 14

Type of errors	Under regular schedule		Under changed schedule	
	before class	after class	before class	after class
Raised wrong hand	2 pupils	12 pupils	2 pupils	3 pupils
Hesitated in choice of hand	4 "	2 "	4 "	4 "
Delayed raising of hand:				
up to 25 percent	twice	once	once	once
up to 50 "	-	once	-	-
up to 75 "	-	once	-	-
(almost entire class)	-	-	-	-
Lowered hand too soon (before signal)	1 pupil	1 pupil	1 pupil	1 pupil
Hesitated to lowering hand	2 pupils	-	3 pupils	3 pupils
Errors (delay) in lowering hand after signal)	1	3	-	1

In concluding the presentation of the data of the present work, we consider it expedient to cite in a generalized and brief form the opinion of pedagogues on the experimental regimen in the first grade.

According to the reports of teachers of experimental classes, the pupils become more quiet and more responsive in their classes when transferred to a changed school schedule. Upon return from the court, even after the third recess, they manifest, according to the teachers, the same cheerfulness and capacity for work as during the first class. The teachers note that they, too, tire less, and that they are capable of conducting the class and managing the children with more ease.

On the basis of the above, we can arrive at the following practical conclusions:

1) Under conditions of a regular school-day schedule -- each class being 45 minutes in length -- there develop changes of cortical dynamics up to post liminal (protective) inhibition in first-grade pupils toward the end of the school day.

2) Under a changed school regimen -- classes 35 minutes long -- with recesses prolonged by 10 minutes and conducted in the form of organized active rest period, the phenomena of cortical dynamics impairment are markedly reduced, and are hardly observed, if, under conditions of a changed school schedule, the recesses are conducted in the open air.

3) The results of the described investigations demonstrate the harm caused to first-grade pupils by the existing school-day schedule and dictate the necessity of:

a) immediate change of the existing school-day schedule for the first grade by means of shortening the duration of classes to 30-35 minutes, increasing the recess periods and their obligatory conduct in the open air in the form of an organized active rest period; b) revision of the first-grade school programs, in connection with the above-mentioned task regarding their reduction.

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